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MID-TERM EXAMINATION (2023-24)
CLASS : XI
SUBJECT: PHYSICS (042)

समय : 3 घंटे
Time Allowed : 3 hours

अधिकतम अंक - 70
Maximum Marks : 70

सामान्य निर्देश:

निम्नलिखित निर्देशों को सावधानीपूर्वक पढ़िए और उनका सख्ती से पालन कीजिए -

1. इस प्रश्न पत्र में कुल 33 प्रश्न हैं। सभी प्रश्न अनिवार्य हैं।
2. प्रश्न प्रश्न पत्र में पांच खंड हैं। खंड-क, खंड-ख, खंड-ग, खंड-घ एवं खंड ङ।
3. खंड क में 16 प्रश्न हैं, 12 बहुविकल्पीय प्रश्न और 4 अभिकथन-कारण प्रश्न हैं प्रत्येक 1 अंक का है। खंड ख में 5 प्रश्न हैं, प्रत्येक 2 अंकों का है। खंड ग में 7 प्रश्न हैं, प्रत्येक 3 अंकों का है। खंड घ में 2 केस-आधारित प्रश्न हैं, प्रत्येक 4 अंकों का है। खंड ङ में 3 दीर्घ उत्तरीय प्रश्न हैं, प्रत्येक 5 अंकों का है।
4. प्रश्न पत्र में कोई समग्र विकल्प नहीं है। यद्यपि खंड ख के 1 प्रश्न में, खंड ग में 1 प्रश्न में, खंड घ के 2 प्रश्नों में और खंड ङ के 3 प्रश्नों में आंतरिक विकल्प का प्रावधान दिया गया है।
5. कैलकूलेटर का प्रयोग वर्जित है।

GENERAL INSTRUCTIONS:

Read the following questions very carefully and strictly follow them :

1. This question paper contains 33 questions. All questions are compulsory.
2. This question paper is divided into 5 sections - A, B, C, D and E.
3. Section A contains 16 questions, 12 MCQ and 4 Assertion Reasoning based on 1 mark each. Section B contains 5 questions of 2 marks each. Section C contains 7 questions of 3 marks each. Section D contains 2 case study based questions of 4 marks each. Section E contains 3 long answer questions of 5 marks each.
4. There is no over all choice. However an internal choice has been given in 1 question in Section B, 2 questions in Section C, 1 question in each CBQ in Section D and all 3 questions in Section E.
5. Use of calculator is NOT allowed.

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SECTION-A

1. The dimensions in length in the dimensional formula of pressure is : (1)

(a) 1 (b) -1

(c) 2 (d) -2

2. A person covers a part of distance with speed v_1 and the remaining distance with speed v_2 but in same time. The average speed of the entire journey is : (1)

(a) $\frac{v_1 + v_2}{2}$ (b) $\frac{v_1 + v_2}{v_1 . v_2}$

(c) $\frac{v_1 . v_2}{v_1 + v_2}$ (d) $\frac{2v_{12}}{v_1 + v_2}$

3. The horizontal component of velocity of a projectile thrown at angle θ from ground : (1)

(a) increases

(b) decreases

(c) increases from starting point to the maximum height and then decreases

(d) remains constant

4. If a constant force is applied to an object, its acceleration will be : (1)

(a) directly proportional to its mass

(b) inversely proportional to its mass

(c) independent of its mass

(d) zero

5. The magnitude and direction of the net force acting on a stone of mass 0.1 kg, just after it is dropped from the window of a train accelerating with 1 m/s^2. (Take g = 10 m/s^2) (1)

(a) 10 N vertically upwards

(b) 0.1 N vertically downwards

(c) 1N vertically downwards

(d) no net force acts on the stone

6. When a body is thrown up, work done by gravity on the body is : (1)

(a) positive (b) negative

(c) zero (d) given data is insufficient

7. A fire cracker following a parabolic path explodes in mid-air. The centre of mass of all the fragments will follow a path : (1)

(a) along same parabola (b) along different parabola

(c) along vertically down (d) on straight horizontal path

8. Angular velocity of minute's hand of a clock is : (1)

(a) $\frac{\pi}{30}$ rad/s (b) $\frac{\pi}{1800}$ rad/s

(c) $\frac{2\pi}{1800}$ rad/s (d) $\frac{\pi}{360}$ rad/s

9. The linear momentum of a body is increased by 10%. The percentage increase in its kinetic energy is : (1)

(a) 10% (b) 11%

(c) 20% (d) 21%

10. The magnitude of the sum of the vectors $\vec{A} = 3\hat{i}$ and $\vec{B} = 4\hat{j}$ is : (1)

(a) 1 (b) 4

(c) 5 (d) 7

11. Momentum per unit area has the dimensions : (1)

(a) $[ML^{-1}T^{-1}]$ (b) $[ML^{-2}T^{-1}]$

(c) $[ML^{-2}T^{-2}]$ (d) $[ML^{-1}T^{-2}]$

12. The distance traversed, during equal intervals of time, by a body falling from rest, stand to one another in the ratio : (1)

(a) 1 : 2 : 3 : 4 ..... (b) 1 : 3 : 5 : 7 ....

(c) 1 : 4 : 9 : 16 ..... (d) 1 : 8 : 27 : 64 ....

Note : In question number 13 to 16, two statements are given, one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the code (A), (B), (C) and (D) as given below:

(A) Both Assertion (A) and Reason (R) are true and (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true and (R) is the not correct explanation of Assertion (A).

(C) Assertion (A) is true and Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

13. Assertion (A) : Force of action and reaction never cancel each other. (1)

Reason (R) : The forces of action and reaction act always on different bodies.

14. Assertion (A) : Work is a scalar quantity. (1)

Reason (R) : Work done by a force may be positive, negative or zero.

15. Assertion (A) : The whole mass of anybody can be supposed to be at the centre of mass of the body. (1)

Reason (R) : Centre of mass and centre of gravity of body are at same point.

16. Assertion (A) : Earth revolving around the sun is a three dimensional motion. (1)

Reason (R) : While revolving around the sun, x, y and z coordinates are changing with time.

SECTION-B

17. Derive the following equations of motion for uniformly accelerated motion from velocity-time graph. (2)

(a) $v = u + at$ (b) $s = ut + \frac{1}{2} at^2$

Symbols have their usual meaning.

18 A bullet of mass 20 g moving with a speed of 20 m/s enters a wooden block and is stopped after a distance of 10 cm. What is the average resistance force exerted by the block on the bullet? (2)

OR

If the maximum and the minimum values of the resultant of two forces acting at a point are 10 N and 4 N respectively. Find the magnitude of smaller force.

19. To simulate car accidents, auto manufacturers study the collisions of moving cars with mounted springs of different spring constant. Consider a typical simulation with a car of mass 100 kg moving with a speed 18 km/h on a smooth road and colliding with a horizontally mounted spring of spring constant 6.25×10^3 N/m. What is the maximum compression of the spring? (2)

20. Show that the angular momentum about any point of a single particle moving with constant velocity remains constant throughout the motion. (2)

21. Find the centre of mass of three particles at the vertices of an equilateral triangle of side ℓ. The mass of each particle is m. (2)

SECTION-C

22. Plot the following graphs : (3)

(a) Position-time graph for an object moving with positive constant velocity and initially at origin.

(b) Position-time graph for an object moving with positive acceleration and initially at origin.

(c) Velocity-time graph for an object moving with uniform acceleration.

23. Find the magnitude and direction of the resultant of two vectors $\vec{A}$ and $\vec{B}$ in terms of their magnitudes and angle θ between them. (3)

24. It is well known that a rain drop falls under the influence of downward gravitational force and the opposing resistive force. The later is known to be proportional to the speed of the drop but is otherwise undetermined. Consider a drop of mass 4.00 g falling from a height 1.00 km. It hits the ground with a speed of 50.0 m/s. ($g = 10$ m/s^2) (3)

(a) What is the work done by the gravitational force?

(b) What is the work done by the unknown resistive force?

OR

A bullet of mass 12 g and horizontal speed 78 m/s strikes a block of wood of mass 0.3 kg and instantly comes to rest with respect to the block. The block is suspended from the ceiling by means of thin wires. Calculate the height to which the block rises. ($g = 10\ m/s^2$) (3)

25. The velocity of a particle at an instant is 10 m/s. After 3 seconds its velocity will become 16 m/s. Find its velocity at t = 2s. (3)

26. The velocity of sound waves 'V through a medium varies as $\rho^a.E^b$, where ρ is density of the medium and E is the modulus of elasticity. Find the values of a and b. (3)

27. A pebbles of mass 40 g is thrown vertically upwards. Give the direction and magnitude of the net force on the pebble neglecting (effect of air) in the cases given below: ($g = 10\ m/s^2$) (3)

(a) during its upward motion

(b) during its downward motion

(c) at the highest point where it is momentarily at rest

28. (a) State the law of conservation of angular momentum. (3)

(b) If earth were to shrink suddenly (mass remain constant), what would happen to the length of the day? (Moment of inertia of sphere = $\frac{2}{5}MR^2$ (where R is radius of sphere and M mass of the sphere).

SECTION-D

Case Study Based Questions

29. Read the following paragraph and answer the questions that follow :

In an amusement park, there is a roller coaster ride called "The circular thrill". The roller coaster consist of a circular track with a radius of 8 m. The carts travel at a constant speed of 16 m/s along the track. Students from Class XI Physics group went to the amusement park and were intrigued by the circular motion of the roller coaster. (4)

(i) Which force is responsible for the roller coaster's circular motion?

(a) Gravitational force (b) Friction

(c) Centripetal force (d) Electromagnetic force

(ii) The magnitude of the roller coaster's centripetal acceleration while moving on the track is:

(a) 16 m/s^2 (b) 24 m/s^2

(c) 30 m/s^2 (d) 32 m/s^2

(iii) The main factor that determines the roller coaster's maximum speed on the circular track without any friction :

(a) design of roller coaster (b) height of the track

(c) radius of the circular track (d) time of the day

OR

If the speed of roller coaster is doubled, what will happen to the centripetal force required to keep it moving on same circular track?

(a) it will become quadruple (b) it will become double

(c) it will become half (d) it will become one-fourth

(iv) If the speed of roller coaster is halved and radius of circular track is doubled, what will happen to the centripetal force required?

(a) it will remain same (b) it will become one-fourth

(c) it will become one-fourth (d) it will become one-half

30. Read the following paragraph and answer the questions that follow :

The potential energy brings to one's mind 'stored' energy. The potential energy is the stored energy by virtue of position or configuration of a body. The potential energy stored in raising a body to a height h ($h << Re$) is mgh, where g is acceleration due to gravity and Re is the radius of the earth. g varies with height 'h' as $g' = g\left(1+\frac{h}{Re}\right)^{-2}$ and with depth 'd' as $g' = g\left(1-\frac{d}{Re}\right)$. (4)

(i) If the potential energy of a body at height h from earth's surface is U, then the potential energy of the same body at height ($h' >> h$) will :

(a) increase (b) decrease

(c) remain same (d) does not change with h

(ii) A spring that is compressed has (horizontal spring)

(a) Gravitational potential energy (b) Elastic potential energy

(c) Kinetic energy (d) both (a) and (b)

(iii) The unit of measurement for potential energy is the same as the unit for :

(a) force (b) linear momentum

(c) kinetic energy (d) power per unit time

(iv) A pendulum is at its highest point. What type of energy does it mainly possess?

(a) Gravitational potential energy (b) Elastic potential energy

(c) Kinetic energy (d) both (a) and (c)

OR

At a depth d = Re, the value of g′ will be :

(a) > g (b) < g but finite

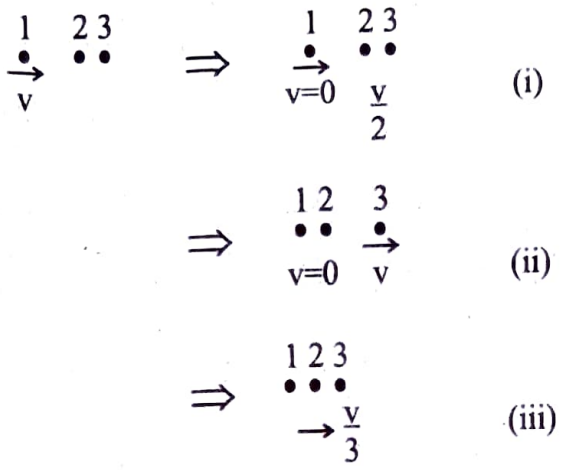
(c) zero (d) does not depend on d

SECTION-E

31. Two identical ball bearings in contact with each other and resting on a frictionless table are hit head-on by another ball bearing of the same mass moving initially with a speed V. In the following three situations (shown in figure)

(a) find the loss in kinetic energy in each case

(b) on the basis of part (a), identify that whether the collision is elastic or inelastic (5)



OR

(a) Define conservative and non-conservative forces. Give one example of each.

(b) Show that total mechanical energy of a body remains conserved in free fall, when it is falling from a height h w.r.t. the ground.

32. A projectile is thrown with initial velocity u at an angle θ upward from the ground. Derive the expression for :

(a) equation of path of projectile

(b) time of flight of projectile

(c) horizontal range of projectile

OR

(a) A projectile is fired from a gun with a muzzle velocity of 200 m/s at an angle of 30° upward from the ground. The maximum height reached would be the same as that by an identical particle fired vertically upwards with a muzzle velocity v. Find the magnitude of v. ($g = 10\ m/s^2$)

(b) Two particles are thrown, each with initial velocity v, from ground at angles $(45° + \theta)$ and $(45° - \theta)$. Show that their horizontal ranges are same.

33. (a) Define static friction, limiting friction and kinetic friction. Plot a graph between the applied force and the force of friction and mark the three frictions on it.

(b) A box of mass 20 kg is placed on a horizontal surface. If coefficient of kinetic friction between the box and the horizontal surface is 0.25, calculate acceleration produced in the box when a force of 100N is applied horizontally. (take g = 10 m/s^2) (5)

OR

(a) Define concurrent forces and their equilibrium.

(b) As shown in the figure, a mass of 6 kg is suspended by a rope of length 2 m from the ceiling. A force of 50 N in the horizontal direction is applied at the mid-point P of the rope. What is the angle the rope makes with the vertical in equilibrium? Also find tensions T_1 and T_2 in the spring.

(Take g = 10 m/s^2, neglect the mass of the rope)